Chapter 7

FUTURE RESEARCH DIRECTIONS

The results presented in Chapter 5 and the issues discussed in Chapter 6 suggest a number of topics for future work. An investigation of the compatibility of radiant cooling systems with buildings with significant indoor moisture production is a natural follow-up for the technical research described in this thesis. The current general consensus is that, to avoid the negative effects of surface condensation in such buildings, radiant cooling systems would function properly only when combined with very strict zoning of the indoor environment.[1] However, there is currently no definition for the notion of "strict zoning", and no in-depth research has been conducted to determine the consequences of operating a radiant cooling system in a building with significant indoor moisture production in the absence of zoning. The results of such research would be valuable for the definition of the market share that radiant cooling systems could capture in the United States.

A study of the different technologies that can provide the cooling necessary for the operation of building conditioning systems opens an area of combined technical and economic research. Even though there is general consensus that the electricity demand due to space conditioning would decrease if building conditioning systems were combined with alternative cooling sources (cooling towers, ground coupling, thermal storage), in practice most cooling systems work in combination with an electrical chiller. A study of the energy- and cost-related advantages and disadvantages of alternative cooling sources can lead to a partial explanation for the current market preference for electrical chillers. An additional investigation of the performance of all-air systems and radiant cooling systems in combination with alternative cooling sources would evaluate the energy savings potential of radiant cooling systems in the situation in which the use of alternative cooling sources became widespread.

Another technical-economic research area consists of comparing the performance of radiant cooling systems and that of the "alternative" cooling technologies (evaporative cooling, desiccant cooling, absorption cooling) that are already available on the US air-conditioning market. Like radiant cooling systems, alternative cooling technologies theoretically require less energy and peak power to operate, while striving to provide indoor conditions similar to those provided by compressor-driven chillers. In addition, alternative cooling technologies have the advantage of being able to function together with the familiar all-air systems, while the functioning principle of radiant cooling is for the most part, unfamiliar to the public and the building professionals. Defining the sectors of the air-conditioning market where each technology can function optimally, and

1. The purpose of zoning is to isolate the spaces with significant moisture production from the rest of the building, thereby reducing the risk of condensation on the cooling surface of the radiant system.

examining the energy- and cost-related advantages and disadvantages of radiant cooling as compared to the alternative technologies would add to the information necessary to evaluate the chance of radiant cooling systems to be adopted and promoted in the US.

Investigations of user-related advantages and disadvantages of the indoor environment created by radiant cooling systems would contribute to the information about these systems. The data collected so far from buildings equipped with radiant cooling systems indicate that no comfort-related complaints have been documented. The limited character of the available user-related information notwithstanding, it reflects only thermal- and/or health-related comfort criteria, and does not address other subjective issues. For instance, a retail space equipped with a radiant cooling system was found to be virtually dust-free. The explanation of this result rests on the much smaller air supply rates required by this retail store, as compared to similar retail stores conditioned by traditional all-air systems. In addition to the benefits of a cleaner environment, the dust-free system eliminates the time that the employees of the retail store must spend dusting the shelves, allowing them to perform other duties instead. This example shows the importance of interviews and informal discussions with building occupants. Such work would provide some valuable insight into the reality of spending several hours every day in a building conditioned by a radiant cooling system.

Similar investigations of the user-related advantages and disadvantages of innovative all-air systems would help identify directions for the improvement of existing all-air systems. In particular, individually-controlled task conditioning systems deserve more research. Task conditioning system allow the building occupant to adjust the speed, direction, and sometimes temperature of the incoming supply air. They have the potential to improve thermal comfort, ventilation efficiency and air quality. Depending on their design, the use of task conditioning systems instead of traditional air-conditioning systems can lead to energy savings. Defining the sectors of the air-conditioning market where innovative all-air systems in general, and task conditioning systems in particular, can function optimally would add to the information necessary to evaluate the chance of alternative cooling technologies to capture a significant share of the US air-conditioning market.

Finally, the social aspects of space conditioning constitute a research area of increasing interest. It is generally accepted that individual preferences for thermal and other environmental conditions vary from hour to hour, day to day, and person to person, according to a wide range of influences: physiological and psychological factors, cultural factors, clothing, acclimatization, etc. Yet current building standards are largely based on comfort equations developed in the 1970s, originating from experiments conducted in steady-state conditions. As a result, when HVAC engineers design their systems to comply with building standards, they create indoor environments that are uncomfortable for many individuals. This discrepancy between the perceived need for comfort and the techniques used to provide comfort calls for research focusing on individual variation, as well as on past and current norms and expectations. Such research would deepen the

understanding of historical and present methods of climate control, and could unveil new techniques that can simultaneously save energy and improve occupant comfort. Ultimately, such research could constitute the basis for a new collective attitude towards the issue of energy conservation in buildings.